RADIAN CORPORATION

FINAL REPORT

DISCUSSIONS OF CLIMATOLOGY OF INDIVIDUAL PROPOSED ACTIONS

VOLUME 3

DCN 77-100-163-02

FINAL REPORT
DISCUSSIONS OF CLIMATOLOGY OF INDIVIDUAL PROPOSED ACTIONS

VOLUME 3

5 August 1977

Presented to:

Bureau of Land Management
Albuquerque District Office
3550 Pan American Freeway NE
PO Box 6770
Albuquerque, NM 87107

Prepared by:

Radian Corporation Staff

TABLE OF CONTENTS

		Page
1.0	DISCUSSION OF CLIMATOLOGY FOR AMCOAL SUNDANCE MINE	1
2.0	DISCUSSION OF CLIMATOLOGY FOR THE GAMERCO COAL FIELD	6
3.0	DISCUSSION OF CLIMATOLOGY FOR THE WESTERN COAL TRACT	11
4.0	DISCUSSION OF CLIMATOLOGY FOR THE SALT RIVER PROJECT UNIT I (WEST TRACT)	16
5.0	DISCUSSION OF CLIMATOLOGY FOR THE SALT RIVER PROJECT, UNIT II (EAST TRACT)	21
6.0	DISCUSSION OF CLIMATOLOGY FOR THE STAR LAKE TRACT OF FREEMAN-UNITED MINE (SALAZAR MINE)	26
7.0	DISCUSSION OF CLIMATOLOGY FOR THE ARCH MINERAL TRACT	31
8.0	DISCUSSION OF CLIMATOLOGY FOR THE PEABODY COAL TRACT	36
9.0	DISCUSSION OF CLIMATOLOGY FOR THE WESTERN COAL BISTI TRACT	40
10.0	DISCUSSION OF CLIMATOLOGY FOR THE PUBLIC SERVICE COMPANY OF NEW MEXICO ELECTRIC PLANT	44

TABLE OF CONTENTS (Contd)

		Page
11.0	DISCUSSION FO CLIMATOLOGY FOR THE PROPOSED ATCHISON, TOPEKA, AND SANTA FE RAILROAD THROUGH MC KINLEY AND SAN JUAN COUNTIES ----------	48
12.0	DISCUSSION OF CLIMATOLOGY FOR THE PROPOSED ATCHISON, TOPEKA, AND SANTA FE RAILROAD FROM GALLO WASH TO THE NAVAJO RESERVATION -------------	54
13.0	DISCUSSION OF CLIMATOLOGY FOR THE PROPOSED RAILROAD FROM THE SOUTHERN BOUNDARY OF THE NAVAJO RESERVATION TO GALLUP (CONSOLIDATED COAL COMPANY AND EL PASO NATURAL GAS COMPANY) ----	59
14.0	DISCUSSION OF CLIMATOLOGY FOR THE PROPOSED RAILROAD THROUGH SAN JUAN COUNTY, WEST OF FARMINGTON (CONSOLIDATED COAL AND EL PASO NATURAL GAS COMPANIES) ---------------------------	64
APPENDIX A -	CRITERIA FOR DETERMINING PASQUILL STABILITY CLASSES ---------------------------	69

1.0 DISCUSSION OF CLIMATOLOGY FOR AMCOAL SUNDANCE MINE

The Amcoal Mine tract is located on a plateau in the southwest portion of the Star Lake - Bisti region. The elevation within this tract varies from 6880 to 7665 feet. The climate is best characterized as semi-arid steppe.

Because of the semi-arid nature of this tract, diurnal temperature ranges are large. The annual average temperature is about 46°F. The hottest month is July, when temperatures may reach as high as the low 90's. The coldest month is January, when temperatures as low as -15°F may occur. (The temperatures given are averages for the whole tract. Because of significant elevation differences across the area, temperatures will vary somewhat. As a general rule, temperatures will vary about 5F° per thousand feet elevation change.)

Precipitation is sparse in the tract, since little surface moisture makes its way into the region from the main moisture source, the Pacific Ocean. The annual average precipitation is only 13.5 inches. There are some orographic influences on precipitation in this tract, so there is some spacial variation of the precipitation totals. The wettest month is August, when an average of 2.1 inches of precipitation occurs, while the driest month is November, when only about 0.6 inch of precipitation occurs.

Snowfall accounts for some of the moisture received in the tract. The average annual snowfall is 36 inches, with the greatest monthly snowfall falling in December or January, depending on the year inspected.

The surface winds in the tract result from a mixture of synoptic-scale and terrain-induced effects. The prevailing surface wind direction is west-southwesterly. Winds from the northwest and southeast sectors are fairly uncommon, considering the tract as a whole. When both the synoptic-scale pressure gradient is weak and the winds are light, anabatic (upslope) winds may affect a valley location during the day and katabatic (drainage or downslope) winds may occur at night in the valley. The direction of the anabatic or katabatic flow depends on the orientation of the valley.

The strongest winds in the region occur during the spring, when low pressure systems tracking through New Mexico and Colorado cause the development of strong southwesterly and westerly winds. The lightest winds occur during the winter, when pressure gradients are weak and local circulations do not increase the winds appreciably.

The upper air winds, which may occasionally transport pollutants for long distances, are stronger than those winds experienced at the surface because of the absence of frictional effects. These winds normally have a westerly component. A thorough discussion and the data presentation for winds at the 10,000-foot level can be found in the regional meteorological discussion.

A combination of low mixing heights and light transport winds occasionally persists over the region for an extended period of time, causing periods of poor dispersion. These episodes are most frequent during the winter, but also occur during the summer and fall. Poor dispersion conditions are infrequent during the spring because of strong transport winds and frequent air mass changes.

Ground-based radiation inversions are most frequent during the winter and fall and least frequent during the spring. On an annual average basis, the tract experiences low-level inversions about 42 percent of the time.

Mixing depths and ventilation are quite variable on a diurnal basis as well as on a seasonal basis at the tract. Morning mixing depths and ventilation values are low throughout the year. During the afternoon, however, the mixing depths and ventilation increase noticeably, particularly during the spring and summer. In general, the lowest mixing depths and ventilation values occur during the winter, when stagnating anticyclones are frequent in the Four Corners region.

The tract receives an unusually high percentage of the unstable Pasquill stability classes ("A", "B", and "C") on an annual basis as well as a fairly high frequency of occurrence of stable conditions ("E" and "F") during nocturnal periods. This is due to the high incidence of clear skies and light winds in the district. A more detailed discussion of stability can be found in the regional meteorological discussion. The criteria for determining the stability classes are given in Appendix A of Volume 3.

The visibility in the area is good, averaging about 15 miles on an annual average. The visibility is best during the summer and lowest during the winter.

Because of the semi-arid nature of this region, relative humidities (and dew points) are low throughout the year. The annual average relative humidity over the tract is 62 percent. The annual average dew point is only 26°F. The seasonal average relative humidity is lowest during the early summer and highest

during mid to late summer. Because of significant elevation differences within the tract, relative humidities will vary somewhat (increase with elevation). Dew points will vary only slightly (decrease with elevation).

Evaporation in the region is greatest during the dry, windy months of spring and lowest during the winter months. On an annual average basis, lake evaporation is 51 inches and pan evaporation is 75 inches. The growing season is approximately 140 days, with the first fall freeze occurring in early October and the last spring freeze occurring in mid-May.

The region occasionally experiences heavy, persistent fogs during the winter, when cold air associated with a stationary high pressure system becomes trapped in basins (often over snow-covered ground). The tract experiences an average of 35 foggy days each year.

Insolation is intense at the tract during most of the year because of the dry air which normally prevails, combined with the relatively high elevation of the site. The tract receives about 516 langleys of insolation during an average day (a total of 188,340 langleys/year). The most insolation is received during June, while the least insolation on a monthly basis is received during December. Cloud cover averages 4.5 out of 10 on an annual average basis. This means that during the daylight hours during the year 45 percent of the sky is covered by clouds on the average.

The region seldom experiences severe storms. Dust-storms do occur during the spring, but they are normally short-lived because of the steady eastward progression of the storm system involved. Sustained winds of 84 miles per hour (extreme mile winds) can be expected once every one hundred years, while

sustained winds of 81 miles per hour can be expected once every fifty years. Blizzards will affect the region on occasion, during the winter or early spring. Severe thunderstorms with strong, gusty winds and/or hail also affect the region occasionally during the late spring and summer. The tract experiences a hailstorm about 6 times during an average year; however, the size of hailstones may often be so small that little damage results.

2.0 DISCUSSION OF CLIMATOLOGY FOR THE GAMERCO COAL FIELD

The Gamerco Coal Field tract is divided northwest/ southeast by a minor plateau averaging about a mile in width, with an average of 250 feet between the top of the plateau and the valley floor. It is located in the southwestern corner of the Star Lake - Bisti ES region. The elevation within this tract varies from 6400 to 6790 feet. The climate is best characterized as semi-arid steppe.

Because of the semi-arid nature of this tract, diurnal temperature ranges are large. The annual average temperature is about 48°F. The hottest month is July, when temperatures may reach as high as the low 90's. The coldest month is January, when temperatures as low as -10°F may occur. Small variations in temperature will occur from one place to another in this area due to elevation differences.

Precipitation is sparse in the tract, since little surface moisture makes its way into the region from the main moisture source, the Pacific Ocean. The annual average precipitation is only 10.8 inches. There are orographic influences on precipitation in this tract, so there is some spacial variation of the precipitation totals. The wettest month is August, when an average of 2.1 inches of precipitation occurs, while the driest month is June, when only about 0.5 inch of precipitation occurs.

Snowfall accounts for some of the moisture received in the tract. The average annual snowfall is 24 inches, with the greatest monthly snowfall falling in December or January, depending on the year inspected.

The surface winds in the tract result from a mixture of synoptic-scale and terrain-induced effects. The prevailing surface wind direction is west-southwesterly. Winds from the northwest and southeast sectors are fairly uncommon, considering the tract as a whole. When both the synoptic-scale pressure gradient is weak and the winds are light, anabatic (upslope) winds may affect a valley location during the day and katabatic (drainage or downslope) winds may occur at night in the valley. The direction of the anabatic or katabatic flow depends on the orientation of the valley.

The strongest winds in the region occur during the spring, when low pressure systems tracking through New Mexico and Colorado cause the development of strong southwesterly and westerly winds. The lightest winds occur during the winter, when pressure gradients are weak and local circulations do not increase the winds appreciably.

The upper air winds, which may occasionally transport pollutants for long distances, are stronger than those winds experienced at the surface because of the absence of frictional effects. These winds normally have a westerly component. A thorough discussion and the data presentation for winds at the 10,000-foot level can be found in the regional meteorological discussion.

A combination of low mixing heights and light transport winds occasionally persists over the region for an extended period of time, causing periods of poor dispersion. These episodes are most frequent during the winter, but also occur during the summer and fall. Poor dispersion conditions are infrequent during the spring because of the strong transport winds and frequent air mass changes which affect the region.

Ground-based radiation inversions are most frequent during the winter and fall and least frequent during the spring. On an annual average basis, the tract experiences low-level inversions about 42 percent of the time.

Mixing depths and ventilation are quite variable on a diurnal basis as well as on a seasonal basis at the tract. Morning mixing depths and ventilation values are low throughout the year. During the afternoon, however, the mixing depths and ventilation increase noticeably, particularly during the spring and summer. In general, the lowest mixing depths and ventilation values occur during the winter, when stagnating anticyclones are frequent in the Four Corners region.

The tract receives an unusually high percentage of the unstable Pasquill stability classes ("A", "B", and "C") on an annual basis as well as a fairly high frequency of occurrence of stable conditions ("E" and "F") during nocturnal periods. This is due to the high incidence of clear skies and light winds in the district. A more detailed discussion of stability can be found in the regional meteorological discussion. The criteria for determining the stability classes are given in Appendix A of Volume 3.

The visibility in the area is good, averaging about 16 miles on an annual average. The visibility is best during the summer and lowest during the winter.

Because of the semi-arid nature of this region, relative humidities (and dew points) are quite low throughout the year. The annual average relative humidity at the tract is only about 56 percent. (Relative humidity will vary slightly across this tract due to elevation differences.) The annual average dew point

is only 28^{o}F. The seasonal average relative humidity is lowest during the early summer and highest during the winter. The actual moisture content of the air is lowest during the winter and highest during mid to late summer.

Evaporation in the region is greatest during the dry, windy spring months and lowest during the winter months. On an annual average basis, lake evaporation is 50 inches and pan evaporation is 72 inches. The growing season is approximately 140 days, with the first fall freeze occurring in early October and the last spring freeze occurring in mid May.

The region occasionally experiences heavy, persistent fogs during the winter, when cold air associated with a stationary high pressure system becomes trapped in basins (often over snow-covered ground). The tract experiences about 35 foggy days during a typical year.

Insolation is intense at the tract during most of the year because of the dry air which normally prevails, combined with the relatively high elevation of the site. The tract receives about 512 langleys of insolation during an average day (a total of 186,880 langleys/year). The most insolation is received during June, while the least insolation on a monthly basis is received during December. Cloud cover averages 4.5 out of 10 on an annual average basis. This means that during the daylight hours during the year 45 percent of the sky is covered by clouds on the average.

The region seldom experiences severe storms. Dust-storms do occur during the spring, but they are normally short-lived because of the steady eastward progression of the storm

system involved. Sustained winds of up to 84 miles per hour (extreme mile winds) can be expected once every one hundred years, while winds of 81 mph can be expected once every fifty years. Blizzards will affect the region on occasion, during the winter or early spring. Severe thunderstorms with strong, gusty winds and/or hail also affect the region occasionally during the late spring and summer. The tract experiences a hailstorm about six times during an average year; however, the size of hailstones may often be so small that little damage results.

3.0 DISCUSSION OF CLIMATOLOGY FOR THE WESTERN COAL TRACT

The Western Coal tract, the extension of the San Juan Mine, is located in a basin known locally as the Meadows in the northwestern portion of the Star Lake - Bisti ES region. The elevation within this tract varies from 5230 to 5573 feet. The climate is best characterized as semi-arid steppe.

Because of the semi-arid nature of this tract, diurnal temperature ranges are large. The annual average temperature is approximately 52°F. The hottest month is July, when temperatures may reach as high as the upper 90's. The coldest month is January, when temperatures as low as -5°F may occur. Small variations in temperature will occur from one place to another in this area due to elevation differences.

Precipitation is sparse in the tract, since little surface moisture makes its way into the region from the main moisture source, the Pacific Ocean. The annual average precipitation is only 8.8 inches. There are few orographic influences on precipitation in this tract; therefore, only minor spacial variations in precipitation totals occur. The wettest month is August, when an average of 1.5 inches of precipitation occurs, while the driest month is November, when only about 0.4 inch of precipitation occurs.

Snowfall accounts for some of the moisture received in the tract. The average annual snowfall is 24 inches, with the greatest monthly snowfall falling in December or January, depending on the year inspected.

The surface winds at the tract result from a mixture of synoptic-scale and terrain-induced effects. The prevailing surface wind direction is west to west-southwesterly. Much of the tract lies in a basin (The Meadows) oriented north to south and sloping toward the south. When both the synoptic-scale pressure gradient is weak and the winds are light, anabatic (upslope) winds may affect a valley location during the day and katabatic (drainage or downslope) winds may occur at night in the valley.

The strongest winds in the region occur during the spring, when low pressure systems tracking through New Mexico and Colorado cause the development of strong southwesterly and westerly winds. The lightest winds occur during the winter, when pressure gradients are weak and local circulations do not increase the winds appreciably.

The upper air winds, which may occasionally transport pollutants for long distances, are stronger than those winds experienced at the surface because of the absence of frictional effects. These winds normally have a westerly component. A thorough discussion and the data presentation for winds at the 10,000-foot level can be found in the regional meteorological discussion.

A combination of low mixing heights and light transport winds occasionally persists over the region for an extended period of time, causing periods of poor dispersion. These episodes are most frequent during the winter, but also occur during the summer and fall. Poor dispersion conditions are infrequent during the spring because of the strong transport winds and frequent air mass changes which affect the region.

Ground-based radiation inversions are most frequent during the winter and fall and least frequent during the spring. On an annual average basis, the tract experiences low-level inversions about 42 percent of the time.

Mixing depths and ventilation are quite variable on a diurnal basis as well as on a seasonal basis at the tract. Morning mixing depths and ventilation values are low throughout the year. During the afternoon, however, the mixing depths and ventilation increase noticeably, particularly during the spring and summer. In general, the lowest mixing depths and ventilation values occur during the winter, when stagnating anticyclones are frequent in the Four Corners region.

The tract receives an unusually high percentage of the unstable Pasquill stability classes ("A", "B", and "C") on an annual basis as well as a fairly high frequency of occurrence of stable conditions ("E" and "F") during nocturnal periods. This is due to the high incidence of clear skies and light winds in the district. A more detailed discussion of stability can be found in the regional meteorological discussion. The criteria for determining the stability classes are given in Appendix A of Volume 3.

The visibility in the area is good, averaging about 40 miles on an annual average. The visibility is best during the summer and lowest during the winter.

Because of the semi-arid nature of this region, relative humidities (and dew points) are low throughout the year. The annual average relative humidity over the tract is

only approximately 48 percent. The annual average dew point is only about 30°F. The seasonal average relative humidity is lowest during the early summer and highest during the winter, although the actual moisture content of the air is lowest during the winter and highest during the mid to late summer.

Evaporation in the region is greatest during the dry, windy months of spring and lowest during the winter months. On an annual average basis, lake evaporation is 44 inches and pan evaporation is 64 inches. The growing season is approximately 160 days, with the first fall freeze occurring in mid-October and the last spring freeze occurring in early May.

The region occasionally experiences heavy, persistent fogs during the winter, when cold air associated with a stationary high pressure system becomes trapped in basins (often over snow-covered ground). The tract experiences about 15 foggy days during a typical year.

Insolation is intense at the tract during most of the year because of the dry air which normally prevails, combined with the relatively high elevation of the site. The tract receives about 505 langleys of insolation during an average day (a total of 184,325 langleys/year). The most insolation is received during June, while the least insolation on a monthly basis is received during December. Cloud cover averages 4.8 out of 10 on an annual average basis. This means that during the daylight hours during the year 48 percent of the sky is covered by clouds on the average.

The region seldom experiences severe storms. Duststorms do occur during the spring, but they are normally short-lived because of the steady eastward progression of the storm system involved. Sustained winds of 84 miles per hour (extreme

mile winds) can be expected once every one hundred years, while winds of 81 miles per hour can be expected once every fifty years. Blizzards will affect the region on occasion, during the winter or early spring. Severe thunderstorms with strong, gusty winds and/or hail also affect the region occasionally during the late spring and summer. The tract experiences a hailstorm about 6 times during an average year; however, the size of hailstones may often be so small that little damage results.

4.0 DISCUSSION OF CLIMATOLOGY FOR THE SALT RIVER PROJECT, UNIT I (WEST TRACT)

The Salt River Project, Unit I, (West Tract), is located on a sloping (northeast to southwest) plateau (cut by arroyos in the southern portion of the tract) in the north central portion os the Star Lake - Bisti ES region. The elevation within this tract varies from 6270 to 6760 feet. The climate is best characgerized as semi-arid steppe.

Because of the semi-arid nature of this tract, diurnal temperature ranges are large. The annual average temperature is about 51°F. The hottest month is July, when temperatures may reach as high as the mid 90's. The coldest month is January, when temperatures as low as -10°F may occur. Small variations in temperature will occur from one place to another in this area due to elevation differences.

Precipitation is sparse in the tract, since little surface moisture makes its way into the region from the main moisture source, the Pacific Ocean. The annual average precipitation is only 9.7 inches. There are few orographic influences on precipitation in this tract, so there is little spacial variation of the precipitation totals. The wettest month is August, when an average of 2.0 inches of precipitation occurs, while the driest month is November, when only about 0.4 inch of precipitation occurs.

Snowfall accounts for some of the moisture received in the tract. The average annual snowfall is 23 inches, with the greatest monthly snowfall falling in December or January, depending on the year inspected.

The surface winds in the tract result from a mixture of synoptic-scale and terrain-induced effects. The prevailing surface wind direction is west-southwesterly. Winds from the northwest and southeast sectors are fairly uncommon, considering the tract as a whole. When both the synoptic-scale pressure gradient is weak and the winds are light, anabatic (upslope) winds may affect a valley location during the day and katabatic (drainage or downslope) winds may occur at night in the valley. The direction of the anabatic or katabatic flow depends on the orientation of the valley.

The strongest winds in the region occur during the spring, when low pressure systems tracking through New Mexico and Colorado cause the development of strong southwesterly and westerly winds. The lightest winds occur during the winter, when pressure gradients are weak and local circulations do not increase the winds appreciably.

The upper air winds, which may occasionally transport pollutants for long distances, are stronger than those winds experienced at the surface because of the absence of frictional effects. These winds normally have a westerly component. A thorough discussion and the data presentation for winds at the 10,000-foot level can be found in the regional meteorological discussion.

A combination of low mixing heights and light transport winds occasionally persists over the region for an extended period of time, causing periods of poor dispersion. These episodes are most frequent during the winter, but also occur during the summer and fall. Poor dispersion conditions are infrequent during the spring because of the strong transport winds and frequent air mass changes which affect the region.

Ground-based radiation inversions are most frequent during the winter and fall and least frequent during the spring. On an annual average basis, the tract experiences low-level inversions about 42 percent of the time.

Mixing depths and ventilation are quite variable on a diurnal basis as well as on a seasonal basis at the tract. Morning mixing depths and ventilation values are low throughout the year. During the afternoon, however, the mixing depths and ventilation increase noticeably, particularly during the spring and summer. In general, the lowest mixing depths and ventilation values occur during the winter, when stagnating anticyclones are frequent in the Four Corners region.

The tract receives an unusually high percentage of the unstable Pasquill stability classes ("A", "B", and "C") on an annual basis as well as a fairly high frequency of occurrence of stable conditions ("E" and "F") during nocturnal periods. This is due to the high incidence of clear skies and light winds in the district. A more detailed discussion of stability can be found in the regional meteorological discussion. The criteria for determining the stability classes are given in Appendix A of Volume 3.

The visibility in the area is good, averaging about 40 miles on an annual average. The visibility is best during the summer and lowest during the winter.

Because of the semi-arid nature of this region, relative humidities (and dew points) are quite low throughout the year. The annual average relative humidity at the tract is only about 46 percent. The annual average dew point is only 28°F. The seasonal average relative humidity is lowest during

the early summer and highest during the winter, although the actual moisture content of the air is lowest during the winter and highest during mid to late summer.

Evaporation in the region is greatest during the dry, windy spring months and lowest during the winter months. On an annual average basis, lake evaporation is 45 inches and pan evaporation is 66 inches. The growing season is approximately 150 days, with the first fall freeze occurring in early October and the last spring freeze occurring in mid May.

The region occasionally experiences heavy, persistent fogs during the winter, when cold air associated with a stationary high pressure system becomes trapped in basins (often over snow-covered ground). The tract experiences about 15 foggy days during a typical year.

Insolation is intense at the tract during most of the year because of the dry air which normally prevails, combined with the relatively high elevation of the site. The tract receives about 504 langleys of insolation during an average day (a total of 183,960 langleys/year). The most insolation is received during June, while the least insolation on a monthly basis is received during December. Cloud cover averages 4.9 out of 10 on an annual average basis. This means that during the daylight hours during the year 49 percent of the sky is covered by clouds on the average.

The region seldom experiences severe storms. Duststorms do occur during the spring, but they are normally short-lived because of the steady eastward progression of the storm system involved. Sustained winds of up to 84 miles per hour (extreme mile winds) can be expected once every one hundred years, while

winds of 81 mph can be expected once every fifty years. Blizzards will affect the region on occasion, during the winter or early spring. Severe thunderstorms with strong, gusty winds and/or hail also affect the region occasionally during the late spring and summer. The tract experiences a hailstorm about 6 times during an average year; however, the size of hailstones may often be so small that little damage results.

5.0 DISCUSSION OF CLIMATOLOGY FOR THE SALT RIVER PROJECT, UNIT II (EAST TRACT)

The Salt River Project, Unit II (East Tract) is located on a plateau cut by arroyos in the north central portion of the Star Lake - Bisti ES region. The elevation within this tract varies from 6625 to 7042 feet. The climate is best characterized as semi-arid steppe.

Because of the semi-arid nature of this tract, diurnal temperature ranges are large. The annual average temperature is about $40^{\circ}F$. The hottest month is July, when temperatures may reach as high as the mid 90's. The coldest month is January, when temperatures as low as $-10^{\circ}F$ may occur. Small variations in temperature will occur from one place to another in this area due to elevation differences.

Precipitation is sparse in the tract, since little surface moisture makes its way into the region from the main moisture source, the Pacific Ocean. The annual average precipitation is only 9.7 inches. There are some orographic influences on precipitation in this tract, so there is some spacial variation of the precipitation totals. The wettest month is August, when an average of 2.0 inches of precipitation occurs, while the driest month is November, when only about 0.4 inch of precipitation occurs.

Snowfall accounts for some of the moisture received in the tract. The average annual snowfall is 23 inches, with the greatest monthly snowfall falling in December or January, depending on the year inspected.

The surface winds in the tract result from a mixture of synoptic-scale and terrain-induced effects. The prevailing surface wind direction is west-southwesterly. Winds from the northwest and southeast sectors are fairly uncommon, considering the tract as a whole. When both the synoptic-scale pressure gradient is weak and the winds are light, anabatic (upslope) winds may affect a valley location during the day and katabatic (drainage or downslope) winds may occur at night in the valley. The direction of the anabatic or katabatic flow depends on the orientation of the valley.

The strongest winds in the region occur during the spring, when low pressure systems tracking through New Mexico and Colorado cause the development of strong southwesterly and westerly winds. The lightest winds occur during the winter, when pressure gradients are weak and local circulations do not increase the winds appreciably.

The upper air winds, which may occasionally transport pollutants for long distances, are stronger than those winds experienced at the surface because of the absence of frictional effects. These winds normally have a westerly component. A thorough discussion and the data presentation for winds at the 10,000-foot level can be found in the regional meteorological discussion.

A combination of low mixing heights and light transport winds occasionally persists over the region for an extended period of time, causing periods of poor dispersion. These episodes are most frequent during the winter, but also occur during the summer and fall. Poor dispersion conditions are infrequent during the spring because of the strong transport winds and frequent air mass changes which affect the region.

Ground-based radiation inversions are most frequent during the winter and fall and least frequent during the spring. On an annual average basis, the tract experiences low-level inversions about 42 percent of the time.

Mixing depths and ventilation are quite variable on a diurnal basis as well as on a seasonal basis at the tract. Morning mixing depths and ventilation values are low throughout the year. During the afternoon, however, the mixing depths and ventilation increase noticeably, particularly during the spring and summer. In general, the lowest mixing depths and ventilation values occur during the winter, when stagnating anticyclones are frequent in the Four Corners region.

The tract receives an unusually high percentage of the unstable Pasquill stability classes ("A", "B", and "C") on an annual basis as well as a fairly high frequency of occurrence of stable conditions ("E" and "F") during nocturnal periods. This is due to the high incidence of clear skies and light winds in the district. A more detailed discussion of stability can be found in the regional meteorological discussion. The criteria for determining the stability classes are given in Appendix A of Volume 3.

The visibility in the area is good, averaging about 40 miles on an annual average. The visibility is best during the summer and lowest during the winter.

Because of the semi-arid nature of this region, relative humidities (and dew points) are low throughout the year. The annual average relative humidity over the tract is only about 49 percent. The annual average dew point is only 27°F. The seasonal average relative humidity is lowest during

the early summer and highest during the winter, although the actual moisture content of the air is lowest during the winter and highest during mid to late summer.

Evaporation in the region is greatest during the dry, windy spring months and lowest during the winter months. On an annual average basis, lake evaporation is 45 inches and pan evaporation is 66 inches. The growing season is approximately 150 days, with the first fall freeze occurring in early October and the last spring freeze occurring in mid-May.

The region occasionally experiences heavy, persistent fogs during the winter, when cold air associated with a stationary high pressure system becomes trapped in basins (often over snow-covered ground). The tract experiences about 18 foggy days during a typical year.

Insolation is intense at the tract during most of the year because of the dry air which normally prevails, combined with the relatively high elevation of the site. The tract receives about 504 langleys of insolation during an average day (a total of 183,960 langleys/year). The most insolation is received during June, while the least insolation on a monthly basis is received during December. Cloud cover averages 4.9 out of 10 on an annual average basis. This means that during the daylight hours during the year 49 percent of the sky is covered by clouds on the average.

The region seldom experiences severe storms. Dust-storms do occur during the spring, but they are normally short-lived because of the steady eastward progression of the storm system involved. Sustained winds of up to 84 miles per hour (extreme mile winds) can be expected once every one hundred years, while winds of 81 miles per hour can be expected once

every fifty years. Blizzards will affect the region on occasion, during the winter or early spring. Severe thunderstorms with strong, gusty winds and/or hail also affect the region occasionally during the late spring and summer. The tract experiences a hail-storm about 6 times during an average year; however, the size of hailstones may often be so small that little damage results.

6.0 DISCUSSION OF CLIMATOLOGY FOR THE STAR LAKE TRACT OF FREEMAN-UNITED MINE (SALAZAR MINE)

The Star Lake portion of the Freeman United (Salazar Mine) is located in a basin in the east central portion of the Star Lake - Bisti ES region. The elevation within this tract varies from 6595 to 6705 feet. The climate is best characterized as semi-arid steppe.

Because of the semi-arid nature of this tract, diurnal temperature ranges are large. The annual average temperature is about 47°F. The hottest month is July, when temperatures may reach as high as the low 90's. The coldest month is January, when temperatures as low as -10°F may occur. Small variations in temperature will occur from one place to another in this area due to elevation differences.

Precipitation is sparse in the tract, since little surface moisture makes its way into the region from the main moisture source, the Pacific Ocean. The annual average precipitation is only 11.5 inches. There are no orographic influences on precipitation in this tract, so there is no significant spacial variation in the precipitation totals. The wettest month is August, when an average of 2.7 inches of precipitation occurs, while the driest month is November, when only about 0.5 inch of precipitation occurs.

Snowfall accounts for some of the moisture received in the tract. The average annual snowfall is 25 inches, with the greatest monthly snowfall falling in December or January, depending on the year inspected.

The surface winds in the tract result from a mixture of synoptic-scale and terrain-induced effects. The prevailing surface wind direction is west-southwesterly. Winds from the northwest and southeast sectors are fairly uncommon, considering the tract as a whole. When both the synoptic-scale pressure gradient is weak and the winds are light, anabatic (upslope) winds may affect a valley location during the day and katabatic (drainage or downslope) winds may occur at night in the valley. The direction of the anabatic or katabatic flow depends on the orientation of the valley.

The strongest winds in the region occur during the spring, when low pressure systems tracking through New Mexico and Colorado cause the development of strong southwesterly and westerly winds. The lightest winds occur during the winter, when pressure gradients are weak and local circulations do not increase the winds appreciably.

The upper air winds, which may occasionally transport pollutants for long distances, are stronger than those winds experienced at the surface because of the absence of frictional effects. These winds normally have a westerly component. A thorough discussion and the data presentation for winds at the 10,000-foot level can be found in the regional meteorological discussion.

A combination of low mixing heights and light transport winds occasionally persists over the region for an extended period of time, causing periods of poor dispersion. These episodes are most frequent during the winter, but also occur during the summer and fall. Poor dispersion conditions are infrequent during the spring because of strong transport winds and frequent air mass changes.

Ground-based radiation inversions are most frequent during the winter and fall and least frequent during the spring. On an annual average basis, the tract experiences low-level inversions approximately 42 percent of the time.

Mixing depths and ventilation are quite variable on a diurnal basis as well as on a seasonal basis at the tract. Morning mixing depths and ventilation values are low throughout the year. During the afternoon, however, the mixing depths and ventilation increase noticeably, particularly during the spring and summer. In general, the lowest mixing depths and ventilation values occur during the winter, when stagnating anticyclones are frequent in the Four Corners region.

The tract receives an unusually high percentage of the unstable Pasquill stability classes ("A", "B", and "C") on an annual basis as well as a fairly high frequency of occurrence of stable conditions ("E" and "F") during nocturnal periods. This is due to the high incidence of clear skies and light winds in the district. A more detailed discussion of stability can be found in the regional meteorological discussion. The criteria for determining the stability classes are given in Appendix A of Volume 3.

The visibility in the area is good, averaging at least 35 miles on an annual average. The visibility is best during the summer and lowest during the winter.

Because of the semi-arid nature of this region, relative humidities (and dew points) are quite low throughout the year. The annual average relative humidity at the tract is only approximately 53 percent. The annual average dew point is only 28^{o}F. The seasonal average relative humidity is lowest during the early summer and highest during the winter, although the actual

moisture content of the air is lowest during the winter and highest during mid to late summer.

Evaporation in the region is greatest during the dry, windy months of spring and lowest during the winter months. On an annual average basis, lake evaporation is 48 inches and pan evaporation is 68 inches. The growing season is approximately 175 days, with the first fall freeze occurring in late October and the last spring freeze occurring in early May.

The region occasionally experiences heavy, persistent fogs during the winter, when cold air associated with a stationary high pressure system becomes trapped in basins (often over snow-covered ground). The tract experiences about 15 foggy days during a typical year.

Insolation is intense at the tract during most of the year because of the dry air which normally prevails, combined with the relatively high elevation of the site. The tract receives about 505 langleys of insolation during an average day (a total of 184,325 langleys/year). The most insolation is received during June, while the least insolation on a monthly basis is received during December. Cloud cover averages 4.8 out of 10 on an annual average basis. This means that during the daylight hours during the year 48 percent of the sky is covered by clouds on the average.

The region seldom experiences severe storms. Duststorms do occur during the spring, but they are normally short-lived because of the steady eastward progression of the storm system involved. Sustained winds of up to 84 miles per hour (extreme mile winds) can be expected once every one hundred years, while winds of 81 miles per hour can be expected once every fifty years. Blizzards will affect the region on occasion,

during the winter or early spring. Severe thunderstorms with strong, gusty winds and/or hail also affect the region occasionally during the late spring and summer. The tract experiences a hailstorm about 6 times during an average year; however, the size of hailstones may often be so small that little damage results.

7.0 DISCUSSION OF CLIMATOLOGY FOR THE ARCH MINERAL TRACT

The Arch Mineral tract spreads across portions of three townships of land in the west central portion of the Star Lake - Bisti ES region. Topography varies from dry creeks and washes to dry rocky plateaus and mesa tops. The elevation within this tract varies from 5875 to 6405 feet. The climate is best characterized as semi-arid steppe.

Because of the semi-arid nature of this tract, diurnal temperature ranges are large. The annual average temperature is about 50°F. The hottest month is July, when temperatures may reach as high as the mid 90's. The coldest month is January, when temperatures as low as -10°F may occur. Small variations in temperature will occur from one place to another in this area due to elevation differences.

Precipitation is sparse in the tract, since little surface moisture makes its way into the region from the main moisture source, the Pacific Ocean. The annual average precipitation varies from 9.0 inches in the northwestern portion of the tract to 9.6 inches in the southeastern portion of the tract. There are few orographic influences on precipitation in this tract, so there is little spacial variation in the precipitation totals. The wettest month is August, when an average of 1.8 inches of precipitation occurs while the driest month is November, when only about 0.4 inch of precipitation occurs.

Snowfall accounts for some of the moisture received in the tract. The average annual snowfall is 20 inches for the northwestern portion of the tract and 22 inches for the southeastern portion. The greatest monthly snowfall occurs during December or January, depending on the year inspected.

The surface winds in the tract result from a mixture of synoptic-scale and terrain-induced effects. The prevailing surface wind direction is west-southwesterly. Winds from the northwest and southeast sectors are fairly uncommon, considering the tract as a whole. When both the synoptic-scale pressure gradient is weak and the winds are light, anabatic (upslope) winds may affect a valley location during the day and katabatic (drainage or downslope) winds may occur at night in the valley. The direction of the anabatic or katabatic flow depends on the orientation of the valley.

The strongest winds in the region occur during the spring, when low pressure systems tracking through New Mexico and Colorado cause the development of strong southwesterly and westerly winds. The lightest winds occur during the winter, when pressure gradients are weak and local circulations do not increase the winds appreciably.

The upper air winds, which may occasionally transport pollutants for long distances, are stronger than those winds experienced at the surface because of the absence of frictional effects. These winds normally have a westerly component. A thorough discussion and the data presentation for winds at the 10,000-foot level can be found in the regional meteorological discussion.

A combination of low mixing heights and light transport winds occasionally persists over the region for an extended period of time, causing periods of poor dispersion. These episodes are most frequent during the winter, but also occur during the summer and fall. Poor dispersion conditions are infrequent during the spring because of the strong transport winds and frequent air mass changes which affect the district.

Ground-based radiation inversions are most frequent during the winter and fall and least frequent during the spring. On an annual average basis, the tract experiences low-level inversions about 42 percent of the time.

Mixing depths and ventilation are quite variable on a diurnal basis as well as on a seasonal basis at the tract. Morning mixing depths and ventilation values are low throughout the year. During the afternoon, however, the mixing depths and ventilation increase noticeably, particularly during the spring and summer. In general, the lowest mixing depths and ventilation values occur during the winter, when stagnating anticyclones are frequent in the Four Corners region.

The tract receives an unusually high percentage of the unstable Pasquill stability classes ("A", "B", and "C") on an annual basis as well as a fairly high frequency of occurrence of stable conditions ("E" and "F") during nocturnal periods. This is due to the high incidence of clear skies and light winds in the district. A more detailed discussion of stability can be found in the regional meteorological discussion. The criteria for determining the stability classes are given in Appendix A of Volume 3.

The visibility in the area is good, averaging at least 35 miles on an annual average. The visibility is best during the summer and lowest during the winter.

Because of the semi-arid nature of this region, relative humidities (and dew points) are low throughout the year. The annual average relative humidity over the tract is only about 49 percent. The annual average dew point is only

about 29°F. The seasonal average relative humidity is lowest during the early summer and highest during the winter, although the actual moisture content of the air is lowest during the winter and highest during mid to late summer.

Evaporation in the region is greatest during the dry, windy months of spring and lowest during the winter months. On an annual average basis, lake evaporation is 46 inches and pan evaporation is 66 inches. The growing season is approximately 150 days, with the first fall freeze occurring in early October and the last spring freeze occuring in mid-May.

The region occasionally experiences heavy, persistent fogs during the winter, when cold air associated with a stationary high pressure system becomes trapped in basins (often over snow-covered ground). The tract experiences about 15 foggy days during a typical year.

Insolation is intense at the tract during most of the year because of the dry air which normally prevails, combined with the relatively high elevation of the site. The tract receives about 505 langleys of insolation during an average day (a total of 184,325 langleys/year). The most insolation is received during June, while the least insolation on a monthly basis is received during December. Cloud cover averages 4.8 out of 10 on an annual average basis. This means that during the daylight hours during the year 48 percent of the sky is covered by clouds on the average.

The region seldom experiences severe storms. Duststorms do occur during the spring, but they are normally short-lived because of the steady eastward progression of the storm system involved. Winds of up to 84 miles per hour (extreme mile winds)

can be expected once every one hundred years, while winds of 81 miles per hour can be expected once every fifty years. Blizzards will affect the region on occasion, during the winter or early spring. Severe thunderstorms with strong, gusty winds and/or hail also affect the region occasionally during the late spring and summer. The tract experiences a hailstorm about 6 times during an average year; however, the size of hailstones may often be so small that little damage results.

8.0 DISCUSSION OF CLIMATOLOGY FOR THE PEABODY COAL TRACT

The Peabody Coal, Chaco Energy, Cherokee & Pittsburgh Tract spreads across portions of five townships of land in the central portion of the Star Lake - Bisti ES region. The Continental Divide runs northeast-southwest through the eastern section of the Star Lake West Tract. Topography varies from dry washes with steep canyons to rocky plateaus. The elevation within this tract varies from 6315 feet in the Star Lake West Tract to 6894 feet in the Gallo Wash Tract.

Because of the semi-arid nature of this tract, diurnal temperature ranges are large. The annual average temperature is about 48°F. The hottest month is July, when temperatures may reach as high as the low 90's. The coldest month is January, when temperatures as low as -10°F may occur. Small variations in temperature will occur from one place to another in this area due to elevation differences.

Precipitation is sparse in the tract, since little surface moisture makes its way into the region from the main moisture source, the Pacific Ocean. The annual average precipitation is only 10.4 inches. There are few orographic influences on precipitation in this tract, so there is little spacial variation in the precipitation totals. The wettest month is August, when an average of 2.5 inches of precipitation occurs, while the driest month is November, when only about 0.4 inch of precipitation occurs.

Snowfall accounts for some of the moisture received in the tract. The average annual snowfall is 23 inches, with the greatest monthly snowfall falling in December or January, depending on the year inspected.

The surface winds in the tract result from a mixture of synoptic-scale and terrain-induced effects. The prevailing surface wind direction is west-southwesterly. Winds from the northwest and southeast sectors are fairly uncommon, considering the tract as a whole. When the synoptic-scale pressure gradient and winds are light, anabatic (upslope) winds may affect a valley location during the day and katabatic (drainage or downslope) winds may occur at night in the valley. The direction of the anabatic or katabatic flow depends on the orientation of the valley.

The strongest winds in the region occur during the spring, when low pressure systems tracking through New Mexico and Colorado cause the development of strong southwesterly and westerly winds. The lightest winds occur during the winter, when pressure gradients are weak and local circulations do not increase the winds appreciably.

The upper air winds, which may occasionally transport pollutants for long distances, are stronger than those winds experienced at the surface because of the absence of frictional effects. These winds normally have a westerly component. A thorough discussion and the data presentation for winds at the 10,000-foot level can be found in the regional meteorological discussion.

The region occasionally experiences periods of poor dispersion, caused by a combination of low mixing heights and light transport winds which persists over an extended period of time (at least two days). These episodes are most frequent during the winter, but also occur during the summer and fall. Poor dispersion conditions are infrequent during the spring because of strong transport winds and frequent air mass changes.

Ground-based radiation inversions are most frequent during the winter and fall and least frequent during the spring. On an annual average basis, the tract experiences low-level inversions about 42 percent of the time.

Mixing depths and ventilation are quite variable on a diurnal basis as well as on a seasonal basis at the tract. Morning mixing depths and ventilation values are low throughout the year. During the afternoon, however, the mixing depths and ventilation increase noticeably, particularly during the spring and summer. In general, the lowest mixing depths and ventilation values occur during the winter, when stagnating anticyclones are frequent in the Four Corners region.

The tract receives an unusually high percentage of the unstable Pasquill stability classes ("A", "B", and "C") on an annual basis as well as a fairly high frequency of occurrence of stable conditions ("E" and "F") during nocturnal periods. This is due to the high incidence of clear skies and light winds in the district. A more detailed discussion of stability can be found in the regional meteorological discussion. The criteria for determining the stability classes are given in Appendix A of Volume 3.

The visibility in the area is good, averaging at least 35 miles on an annual average. The visibility is best during the summer and lowest during the winter.

Because of the semi-arid nature of this region, relative humidities (and dew points) are quite low throughout the year. The annual average relative humidity at the tract is only about 51 percent. The annual average dew point is only 28°F. The seasonal average relative humidity is lowest during the early summer and highest during the winter, although the actual moisture content of the air is lowest during the winter and highest during the mid to late summer.

Evaporation in the region is greatest during the dry, windy months of spring and lowest during the winter months. On an annual average basis, lake evaporation is 48 inches and pan evaporation is 67 inches. The growing season is approximately 165 days, with the first fall freeze occurring in mid-October and the last spring freeze occurring in early May.

The region occasionally experiences heavy, persistent fogs during the winter, when cold air associated with a stationary high pressure system becomes trapped in basins (often over snow-covered ground). The tract experiences about 15 foggy days during a typical year, with canyons experiencing a few more foggy days.

Insolation is intense at the tract during most of the year because of the dry air which normally prevails, combined with the relative high elevation of the site. The tract receives about 505 langleys of insolation during an average day (a total of 184,325 langleys/year). The most insolation is received during June, while the least insolation on a monthly basis is received during December. Cloud cover averages 4.8 out of 10 on an annual average basis. This means that during the daylight hours during the year 48 percent of the sky is covered by clouds on the average.

The region seldom experiences severe storms. Duststorms do occur during the spring, but they are normally short-lived because of the steady eastward progression of the storm system involved. Winds of up to 84 miles per hour (extreme mile winds) can be expected once every one hundred years, while winds of 81 miles per hour can be expected once every fifty years. Blizzards will affect the region on occasion, during the winter or early spring. Severe thunderstorms with strong, gusty winds and/or hail also affect the region occasionally during the late spring and summer. The tract experiences a hailstorm about 6 times during an average year; however, the size of hailstones may often be so small that little damage results.

9.0 DISCUSSION OF CLIMATOLOGY FOR THE WESTERN COAL BISTI TRACT

The Western Coal Bisti tract is located on a plateau cut by arroyos in the northern sections in the west central portion of the Star Lake - Bisti ES region. The elevation within this tract varies from 5740 to 6075 feet. The climate is best characterized as semi-arid steppe.

Because of the semi-arid nature of this district, diurnal temperature ranges are large. The annual average temperature is about 51°F. The hottest month is July, when temperatures may reach as high as the mid 90's. The coldest month is January, when temperatures as low as -10°F may occur. Small variations in temperatures will occur from one place to another in this area due to elevation differences.

Precipitation is sparse in the tract, since little surface moisture makes its way into the region from the main moisture source, the Pacific Ocean. The annual average precipitation is only 8.7 inches. There are no orographic influences on precipitation in this tract, so there is no significant spacial variation of the precipitation totals. The wettest month is August, when an average of 1.8 inches of precipitation occurs, while the driest month is November, when only about 0.5 inch of precipitation occurs.

Snowfall accounts for some of the moisture received in the tract. The average annual snowfall is 20 inches, with the greatest monthly snowfall falling in December or January, depending on the year inspected.

The surface winds in the tract result from a mixture of synoptic-scale and terrain-induced effects. The prevailing surface wind direction is west-southwesterly. Winds from the northwest and southeast sectors are fairly uncommon, considering the tract as a whole. When both the synoptic-scale pressure gradient is weak and the winds are light, anabatic (upslope) winds may affect a valley location during the day and katabatic (drainage or downslope) winds may occur at night in the valley. The direction of the anabatic or katabatic flow depends on the orientation of the valley.

The strongest winds in the region occur during the spring, when low pressure systems tracking through New Mexico and Colorado cause the development of strong southwesterly and westerly winds. The lightest winds occur during the winter, when pressure gradients are weak and local circulations do not increase the winds appreciably.

The upper air winds, which may occasionally transport pollutants for long distances, are stronger than those winds experienced at the surface because of the absence of frictional effects. These winds normally have a westerly component. A thorough discussion and the data presentation for winds at the 10,000-foot level can be found in the regional meteorological discussion.

A combination of low mixing heights and light transport winds occasionally persists over the region for an extended period of time, causing periods of poor dispersion. These episodes are most frequent during the winter, but also occur during the summer and fall. Poor dispersion conditions are infrequent during the spring because of strong transport winds and frequent air mass changes.

Ground-based radiation inversions are most frequent during the winter and fall and least frequent during the spring. On an annual average basis, the tract experiences low-level inversions approximately 42 percent of the time.

Mixing depths and ventilation are quite variable on a diurnal basis as well as on a seasonal basis at the tract. Morning mixing depths and ventilation values are low throughout the year. During the afternoon, however, the mixing depths and ventilation increase noticeably, particularly during the spring and summer. In general, the lowest mixing depths and ventilation values occur during the winter, when stagnating anticyclones are frequent in the Four Corners region.

The tract receives an unusually high percentage of the unstable Pasquill stability classes ("A", "B", and "C") on an annual basis as well as a fairly high frequency of occurrence of stable conditions ("E" and "F") during nocturnal periods. This is due to the high incidence of clear skies and light winds in the district. A more detailed discussion of stability can be found in the regional meteorological discussion. The criteria for determining the stability classes are given in Appendix A of Volume 3.

The visibility in the area is good, averaging at least 35 miles on an annual average. The average visibility is best during the summer and lowest during the winter.

Because of the semi-arid nature of this region, relative humidities (and dew points) are low throughout the year. The annual average relative humidity over the tract is about 47 percent. The annual average dew point is only 29°F. The seasonal average relative humidity is lowest during the early summer and highest during the winter, although the actual moisture content of the air is lowest during the winter and highest during mid to late summer.

Evaporation in the region is greatest during the dry, windy months of spring and lowest during the winter months. On an annual average basis, lake evaporation is 46 inches and pan evaporation is 67 inches. The growing season is approximately 160 days, with the first fall freeze occurring in mid-October and the last spring freeze occurring in early May.

The region occasionally experiences heavy, persistent fogs during the winter, when cold air associated with a stationary high pressure system becomes trapped in basins (often over snow-covered ground). The tract experiences about 15 foggy days during a typical year.

Insolation is intense at the tract during most of the year because of the dry air which normally prevails, combined with the relatively high elevation of the site. The tract receives about 505 langleys of insolation during an average day (a total of 184,325 langleys/year). The most insolation is received during June, while the least insolation on a monthly basis is received during December. Cloud cover averages 4.8 out of 10 on an annual average basis. This means that during the daylight hours during the year 48 percent of the sky is covered by clouds on the average.

The region seldom experiences severe storms. Duststorms do occur during the spring, but they are normally short-lived because of the steady eastward progression of the storm system involved. Sustained winds of up to 84 miles per hour (extreme mile winds) can be expected once every one hundred years, while winds of 81 miles per hour can be expected once every fifty years. Blizzards will affect the region on occasion, during the winter or early spring. Severe thunderstorms with strong, gusty winds and/or hail also affect the region occasionally during the late spring and summer. The tract experiences a hailstorm about 6 times during an average year; however, the size of hailstones may often be so small that little damage results.

10.0 DISCUSSION OF CLIMATOLOGY FOR THE PUBLIC SERVICE COMPANY OF NEW MEXICO ELECTRIC PLANT

The Public Service Company of New Mexico Electric Plant site is located on a mesa cut by arroyos in the west central portion of the Star Lake - Bisti ES region. The elevation within this tract varies from 5900 to 6050 feet. The climate is best characterized as semi-arid steppe.

Because of the semi-arid nature of this tract, diurnal temperature ranges are large. The annual average temperature is about 50°F. The hottest month is July, when temperatures may reach as high as the mid 90's. The coldest month is January, when temperatures as low as -10°F may occur. Small variations in temperature will occur from one place to another in this area due to elevation differences.

Precipitation is sparse in the tract, since little surface moisture makes its way into the region from the main moisture source, the Pacific Ocean. The annual average precipitation is only 8.7 inches. There are no orographic influences on precipitation in this tract, so there is no significant spacial variation in the precipitation totals. The wettest month is August, when an average of 1.8 inches of precipitation occurs, while the driest month is November, when only about 0.5 inch of precipitation occurs.

Snowfall accounts for some of the moisture received in the tract. The average annual snowfall is 20 inches, with the greatest monthly snowfall occurring during December or January, depending on the year inspected.

The surface winds in the tract result from a mixture of synoptic-scale and terrain-induced effects. The prevailing surface wind direction is west-southwesterly. Winds from the northwest and southeast sectors are fairly uncommon, considering the tract as a whole. When both the synoptic-scale pressure gradient is weak and the winds are light, anabatic (upslope) winds may affect a valley location during the day and katabatic (drainage or downslope) winds may occur at night in the valley. The direction of the anabatic or katabatic flow depends on the orientation of the valley.

The strongest winds in the region occur during the spring, when low pressure systems tracking through New Mexico and Colorado cause the development of strong southwesterly and westerly winds. The lightest winds occur during the winter, when pressure gradients are weak and local circulations do not increase the winds appreciably.

The upper air winds, which may occasionally transport pollutants for long distances, are stronger than those winds experienced at the surface because of the absence of frictional effects. These winds normally have a westerly component. A thorough discussion and the data presentation for winds at the 10,000-foot level can be found in the regional meteorological discussion.

A combination of low mixing heights and light transport winds occasionally persists over the region for an extended period of time, causing periods of poor dispersion. These episodes are most frequent during the winter, but also occur during the summer and fall. Poor dispersion conditions are infrequent during the spring because of strong transport winds and frequent air mass changes.

Ground-based radiation inversions are most frequent during the winter and fall and least frequent during the spring. On an annual average basis, the tract experiences low-level inversions approximately 42 percent of the time.

Mixing depths and ventilation are quite variable on a diurnal basis as well as on a seasonal basis at the tract. Morning mixing depths and ventilation values are low throughout the year. During the afternoon, however, the mixing depths and ventilation increase noticeably, particularly during the spring and summer. In general, the lowest mixing depths and ventilation values occur during the winter, when stagnating anticyclones are frequent in the Four Corners region.

The tract receives an unusually high percentage of the unstable Pasquill stability classes ("A", "B", and "C") on an annual basis as well as a fairly high frequency of occurrence of stable conditions ("E" and "F") during nocturnal periods. This is due to the high incidence of clear skies and light winds in the district. A more detailed discussion of stability can be found in the regional meteorological discussion. The criteria for determining the stability classes are given in Appendix A of Volume 3.

The visibility in the area is good, averaging about 40 miles on an annual average. The visibility is best during the summer and lowest during the winter.

Because of the semi-arid nature of this region, relative humidities (and dew points) are low throughout the year. The annual average relative humidity over the tract is only about 51 percent. The annual average dew point is only 29^{o}F. The seasonal average relative humidity is lowest during the early summer and highest during the winter, although the actual moisture content of the air is lowest during the winter and highest during the mid to late summer.

Evaporation in the region is greatest during the dry, windy spring months and lowest during the winter months. On an annual average basis, lake evaporation is 46 inches and pan evaporation is 72 inches. The growing season is approximately 160 days, with the first fall freeze occurring in mid-October and the last spring freeze occurring in early May.

The region occasionally experiences heavy, persistent fogs during the winter, when cold air associated with a stationary high pressure system becomes trapped in basins (often over snow-covered ground). The tract experiences about 15 foggy days during a typical year.

Insolation is intense at the tract during most of the year because of the dry air which normally prevails, combined with the relatively high elevation of the site. The tract receives about 505 langleys of insolation during an average day (a total of 184,325 langleys/year). The most insolation is received during June, while the least insolation on a monthly basis is received during December. Cloud cover averages 4.8 out of 10 on an annual average basis. This means that during the daylight hours during the year 48 percent of the sky is covered by clouds on the average.

The region seldom experiences severe storms. Duststorms do occur during the spring, but they are normally short-lived because of the steady eastward progression of the storm system involved. Winds of up to 84 miles per hour (extreme mile winds) can be expected once every one hundred years, while winds of 81 miles per hour can be expected once every fifty years. Blizzards will affect the region on occasion, during the winter or early spring. Severe thunderstorms with strong, gusty winds and/or hail also affect the region occasionally during the late spring and summer. The tract experiences a hailstorm about 6 times during an average year; however, the size of hailstones may often be so small that little damage results.

11.0 DISCUSSION OF CLIMATOLOGY FOR THE PROPOSED ATCHISON, TOPEKA, AND SANTA FE RAILROAD THROUGH MC KINLEY AND SAN JUAN COUNTIES

The Atchison, Topeka, and Santa Fe Railway Company (Santa Fe), or its subsidiary, The Star Lake Railroad Company, proposes to construct slightly more than 82 miles of rail line and to operate unit trains through portions of McKinley and San Juan Counties in the southern and central regions of the Star Lake - Bisti ES region. The proposed line runs from Prewitt, on the existing AT&SF main line between Gallup and Grants, northeastward passing Hospah, on then to Pueblo Pintado (Section A). From Pueblo Pintado, a spur branches southeast to Star Lake (Section B) while the line continues from Pueblo Pintado northwestward to Gallo Wash (Section C), encompassing slightly more than 82 miles of rail. The line skirts the Continental Divide for several miles and runs through a variety of land forms, ranging from canyons and washes to high plateaus. The highest elevation along the line is 7400 feet, while the lowest elevation is 6390 feet. The climate is best characterized as semi-arid steppe. (See Section 12.0 of this report for a discussion of the climatology of Section D of the proposed railroad.)

Because of the semi-arid nature of this district, the large elevation differential, and the length of the line over many miles, temperatures vary considerably. Diurnal temperature ranges are large throughout the region. Annual average temperatures range from about 45°F at the higher elevations to about 49°F at the lower elevations. The hottest month is July, when temperatures may reach as high as the mid-90's at lower elevations and near 90°F at the higher elevations. The coldest month is January, when temperatures as low as -10°F may occur at lower elevations and -15°F may occur at the higher elevations.

Precipitation is sparse along each section, since little surface moisture makes its way into the region from the main

moisture source, the Pacific Ocean. There are some orographic influences on precipitation, so there is some spatial variation in the precipitation totals also. The annual precipitation normals range from 9.2 inches in the northwestern portion of Section C to 10.5 inches in the southwestern portion of Section A. Since each of the sections covers such a large cross-section of northwestern New Mexico, a rainfall range along each of these sections is helpful in the characterization of the climatic regime for each of these sections. The annual precipitation in Section A varies from 10.5 inches in the southwestern portion to 9.7 inches in the northeastern portion, with the middle portion receiving only 9.5 inches of precipitation. The annual precipitation in Section B ranges from 10.2 inches over the southeastern portion to 9.7 inches in the northwestern portion. Moreover, the annual precipitation pattern in Section C ranges from 9.7 inches in the southeastern area to 9.2 inches in the northwestern area.

The driest and wettest months are November and August, respectively. Both Sections A and B receive about 2.5 inches of precipitation during August and only 0.4 inch during November. Section C also receives about 0.4 inch during November; however, during August the northwestern portion receives 2.0 inches while the southeastern portion receives 2.4 inches of precipitation.

Snowfall accounts for some of the moisture received in the tracts. The average annual snowfall in Section A ranges from 22 inches in the northeastern portion to 34 inches in the southwestern portion. Along Section B, snowfall is approximately 23 inches. Annual average snowfall along Section C ranges from 20 inches in the northwestern portion to 23 inches in the southeastern portion. The greatest monthly snowfall occurs in either December or January, depending on the year inspected.

The surface winds in the tracts result from a mixture of synoptic-scale and terrain-induced effects. The prevailing surface wind direction is west-southwesterly. Winds from the northwest and southeast sectors are fairly uncommon, considering the tract as a whole. When both the synoptic-scale pressure gradient is weak and the winds are light, anabatic (upslope) winds may affect a valley location during the day and katabatic (drainage or downslope) winds may occur at night in the valley. The direction of the anabatic or katabatic flow depends on the orientation of the valley.

The strongest winds in the region occur during the spring, when low pressure systems tracking through New Mexico and Colorado cause the development of strong southwesterly and westerly winds. The lightest winds occur during the winter, when pressure gradients are weak and local circulations do not increase the winds appreciably.

The upper air winds, which may occasionally transport pollutants for long distances, are stronger than those winds experienced at the surface because of the absence of frictional effects. These winds normally have a westerly component. A thorough discussion and the data presentation for winds at the 10,000-foot level can be found in the regional meteorological discussion.

A combination of low mixing heights and light transport winds occasionally persists over the region for an extended period of time, causing periods of poor dispersion. These episodes are most frequent during the winter, but also occur during the summer and fall. Poor dispersion conditions are infrequent during the spring because of the strong transport winds and frequent air mass changes.

Ground-based radiation inversions are most frequent during the winter and fall and least frequent during the spring. On an annual average basis, the tract experiences low-level inversions approximately 42 percent of the time.

Mixing depths and ventilation are quite variable on a diurnal basis as well as on a seasonal basis at the tracts. Morning mixing depths and ventilation values are low throughout the year. During the afternoon, however, the mixing depths and ventilation increase noticeably, particularly during the spring and summer. In general, the lowest mixing depths and ventilation values occur during the winter, when stagnating anticyclones are frequent in the Four Corners region.

The entire region receives an unusually high percentage of the unstable Pasquill stability classes ("A", "B", and "C") on an annual basis as well as a fairly high frequency of occurrence of stable conditions ("E" and "F") during nocturnal periods. This is due to the high incidence of clear skies and light winds in the district. A more detailed discussion of stability can be found in the regional meteorological discussion. The criteria for determining the stability classes are given in Appendix A of Volume 3.

The visibility in the area is good, averaging at least 35 miles on an annual average. The visibility is best during the summer and lowest during the winter.

Because of the semi-arid nature of this region, relative humidities and dew points are quite low throughout the year. The annual average relative humidity ranges from approximately 49 percent at lower elevations to approximately 55 percent at higher elevations. The annual average dew point ranges from about 27°F at higher elevations to about 28°F at lower elevations. The seasonal average relative humidity is lowest during the early summer and highest during the winter,

although the actual moisture content of the air is lowest during the winter and highest during mid to late summer.

Evaporation in the region is greatest during the dry, windy spring months and lowest during the winter months. On an annual average basis, lake evaporation for Sections B and C is 47 inches and pan evaporation is about 68 inches. The lake evaporation statistics for Section A range from 51 inches in the southwestern portion to 47 inches in the northeast portion. The pan evaporation figures for Section A vary from 71 inches in the southwest portion to 67 inches in the northeast portion.

The growing season varies with altitude and is approximately 150 days in the valleys and 160 days on the plateaus. The first fall freeze occurs in early October in the valley and in mid-October on the plateaus. The last spring freeze occurs in mid-May in the valleys and in early May on the plateaus.

The region occasionally experiences heavy, persistent fogs during the winter, when cold air associated with a stationary high pressure system becomes trapped in basins (often over snow-covered ground). The region experiences as many as 20 to 30 foggy days in the valleys and 15 foggy days on the plateaus during a typical year.

Insolation is intense in the region during most of the year because of the dry air which normally prevails, combined with the relatively high elevation. Sections B and C and most of Section A receive about 505 langleys of insolation during an average day, and the southwestern portion of Section A receives a normal daily insolation of 512 langleys. On an annual basis, the total langleys received are 184,325 (186,880 langleys in the southwestern portion of Section A). The greatest insolation is received

during June, while the least insolation on a monthly basis is received during December. Cloud cover averages about 4.8 out of 10 on an annual average basis. This means that during daylight hours during the year 48 percent of the sky is covered by clouds on the average.

The region seldom experiences severe storms. Duststorms do occur during the spring, but they are normally short-lived because of the steady eastward progression of the storm system involved. Sustained winds of 84 miles per hour (extreme mile winds) can be expected once every one hundred years, while winds of 81 mph can be expected every 50 years. Blizzards will affect the region on occasion, during the winter or early spring. Severe thunderstorms with strong, gusty winds and/or hail also affect the region occasionally during the late spring and summer. The region experiences a hailstorm about 6 times during an average year; however, the size of hailstones may often be so small that little damage results.

12.0 DISCUSSION OF CLIMATOLOGY FOR THE PROPOSED ATCHISON, TOPEKA, AND SANTA FE RAILROAD FROM GALLO WASH TO THE NAVAJO RESERVATION

The Atchison, Topeka and Santa Fe Railway Company (Santa Fe), or its subsidiary, the Star Lake Railroad Company, proposes to construct about 33 miles of rail line and to operate unit trains through a portion of San Juan County, New Mexico, from Gallo Wash, northwestward to the eastern boundary of the Navajo Reservation (Section D). This tract is located in the west central portion of the Star Lake - Bisti ES region. The elevation within the tract varies from 5835 to 6390 feet. The tract is void of steep canyons and high ridges, because it is located predominantly on a plateau. The climate is best characterized as semi-arid steppe.

Because of the semi-arid nature of this district, diurnal temperature ranges are large. The annual average temperature is about 49°F. The hottest month is July, when temperatures may reach as high as the mid 90's. The coldest month is January, when temperatures as low as -10°F may occur. Small variations in temperature will occur across the tract due to elevation differences.

Precipitation is sparse in the tract, since little surface moisture makes its way into the region from the main moisture source, the Pacific Ocean. The annual average precipitation is 8.7 inches for the northwestern portion of the tract and 9.2 inches for the southeastern portion. There are few orographic influences on precipitation in this tract, so there is little spacial variation in the precipitation totals. The wettest month is August, when an average of about 1.9 inches of precipitation occurs, while the driest month is November, when approximately 0.4 inch of precipitation occurs.

Snowfall accounts for some of the moisture received in the tract. The average annual snowfall is 20 inches, with the greatest monthly snowfall occurring during either December or January, depending on the year inspected.

The surface winds in the tract result from a mixture of synoptic-scale and terrain-induced effects. The prevailing surface wind direction is west-southwesterly. Winds from the northwest and southeast sectors are fairly uncommon, considering the tract as a whole. When both the synoptic-scale pressure gradient is weak and the winds are light, anabatic (upslope) winds may affect a valley location during the day and katabatic (drainage or downslope) winds may occur at night in the valley. The direction of the anabatic or katabatic flow depends on the orientation of the valley.

The strongest winds in the region occur during the spring, when low pressure systems tracking through New Mexico and Colorado cause the development of strong southwesterly and westerly winds. The lightest winds occur during the winter, when pressure gradients are weak and local circulations do not increase the winds appreciably.

The upper air winds, which may occasionally transport pollutants for long distances, are stronger than those winds experienced at the surface because of the absence of frictional effects. These winds normally have a westerly component. A thorough discussion and the data presentation for winds at the 10,000-foot level can be found in the regional meteorological discussion.

A combination of low mixing heights and light transport winds occasionally persists over the region for an extended period ot time, causing periods of poor dispersion. These episodes are most frequent during the winter, but also occur during the summer

and fall. Poor dispersion conditions are infrequent during the spring because of strong transport winds and frequent air mass changes.

Ground-based radiation inversions are most frequent during the winter and fall and least frequent during the spring. On an annual average basis, the tract experiences low-level inversions about 42 percent of the time.

Mixing depths and ventilation are quite variable on a diurnal basis as well as on a seasonal basis at the tract. Morning mixing depths and ventilation values are low throughout the year. During the afternoon, however, the mixing depths and ventilation increase noticeably, particularly during the spring and summer. In general, the lowest mixing depths and ventilation values occur during the winter, when stagnating anticyclones are frequent in the Four Corners region.

The tract receives an unusually high percentage of the unstable Pasquill stability classes ("A", "B", and "C") on an annual basis as well as a fairly high frequency of occurrence of stable conditions ("E" and "F") during nocturnal periods. This is due to the high incidence of clear skies and light winds in the district. A more detailed discussion of stability can be found in the regional meteorological discussion. The criteria for determining the stability classes are given in Appendix A of Volume 3.

The visibility in the area is good, averaging at least 35 miles on an annual average. The visibility is being during the summer and lowest during the winter.

Because of the semi-arid nature of this region, relative humidities (and dew points) are quite low throughout the year. The annual average relative humidity at the tract is only approximately 51 percent. The annual average dew point is only 29°F. The seasonal average relative humidity is lowest during the early summer and highest during the winter, although the actual moisture content of the air is lowest during the winter and highest during the mid to late summer.

Evaporation in the region is greatest during the dry, windy spring months and lowest during the winter months. On an annual average basis, lake evaporation is 47 inches and pan evaporation is 67 inches. The growing season in the district is approximately 150 days, with the first fall freeze occurring in early October and the last spring freeze occurring in mid-May.

The region occasionally experiences heavy, persistent fogs during the winter, when cold air associated with a stationary high pressure system becomes trapped in basins (often over snow-covered ground). The tract experiences about 15 foggy days during a typical year.

Insolation is intense at the tract during most of the year because of the dry air which normally prevails, combined with the relatively high elevation of the site. The tract receives about 505 langleys of insolation during an average day (a total of 184,325 langleys/year). The most insolation is received during June, while the least insolation on a monthly basis is received during December. Cloud cover averages 4.8 out of 10 on an annual average basis. This means that during daylight hours during the year 48 percent of the sky is covered by clouds on the average.

The region seldom experiences severe storms. Duststorms do occur during the spring, but they are normally short-lived because of the steady eastward progression of the storm system

involved. Sustained winds of 84 miles per hour (extreme mile winds) can be expected once every one hundred years, while winds of 81 miles per hour can be expected once every fifty years. Blizzards will affect the region on occasion, during the winter or early spring. Severe thunderstorms with strong, gusty winds and/or hail also affect the region occasionally during the late spring and summer. The tract experiences a hailstorm about 6 times during an average year; however, the hailstones are often so small that little damage results.

13.0 DISCUSSION OF CLIMATOLOGY FOR THE PROPOSED RAILROAD FROM THE SOUTHERN BOUNDARY OF THE NAVAJO RESERVATION TO GALLUP (CONSOLIDATED COAL COMPANY AND EL PASO NATURAL GAS COMPANY)

The Consolidated Coal Company and the El Paso Natural Gas Company have proposed a 200-foot right-of-way for the construction of a railroad through a portion of McKinley County west of Gallup, New Mexico in the southwestern portion of the Star Lake - Bisti ES region. The tract would wind primarily through basin topography and range in elevation from approximately 6400 feet at the termination point on the existing Atchison, Topeka, and Santa Fe line to approximately 6800 feet at the southern boundary of the Navajo Indian Reservation. The climate is best characterized as semi-arid steppe.

Because of the semi-arid nature of this district, diurnal temperature ranges are large. The annual average temperature is approximately 47°F. The hottest month is July, when temperatures may reach as high as the low-90's. The coldest month is January, when temperatures as low as -10°F may occur. Small variations in temperature will occur across the tract due to elevation differences.

Precipitation is sparse in the tract, since little surface moisture makes its way into the region from the main moisture source, the Pacific Ocean. The annual average precipitation is only 10.7 inches. There are few orographic influences on precipitation in this tract, so there is little spacial variation in the precipitation totals. The wettest month is June, when an approximate average of 2.2 inches of precipitation occurs, while the driest month is November, when only about 0.5 inch of precipitation occurs.

Snowfall accounts for some of the moisture received in the tract. The average annual snowfall is 24 inches, with the greatest monthly snowfall occurring in December or January, depending on the year inspected.

The surface winds in the tract result from a mixture of synoptic-scale and terrain-induced effects. The prevailing surface wind direction is west-southwesterly. Winds from the northwest and southeast sectors are fairly uncommon, considering the tract as a whole. When both the synoptic-scale pressure gradient is weak and the winds are light, anabatic (upslope) winds may affect a valley location during the day and katabatic (drainage or downslope) winds may occur at night in the valley. The direction of the anabatic or katabatic flow depends on the orientation of the valley.

The strongest winds in the region occur during the spring, when low pressure systems tracking through New Mexico and Colorado cause the development of strong southwesterly and westerly winds. The lightest winds occur during the winter, when pressure gradients are weak and local circulations do not increase the winds appreciably.

The upper air winds, which may occasionally transport pollutants for long distances, are stronger than those winds experienced at the surface because of the absence of frictional effects. These winds normally have a westerly component. A thorough discussion and the data presentation for winds at the 10,000-foot level can be found in the regional meteorological discussion.

A combination of low mixing heights and light transport winds occasionally persists over the region for an extended period of time, causing periods of poor dispersion. These episodes are most frequent during the winter, but also occur during the summer

and fall. Poor dispersion conditions are infrequent during the spring because of strong transport winds and frequent air mass changes.

Ground-based radiation inversions are most frequent during the winter and fall and least frequent during the spring. On an annual average basis, the tract experiences low-level inversions about 42 percent of the time.

Mixing depths and ventilation are quite variable on a diurnal basis as well as on a seasonal basis at the tract. Morning mixing depths and ventilation values are low throughout the year. During the afternoon, however, the mixing depths and ventilation increase noticeably, particularly during the spring and summer. In general, the lowest mixing depths and ventilation values occur during the winter, when stagnating anticyclones are frequent in the Four Corners region.

The tract receives an unusually high percentage of the unstable Pasquill stability classes ("A", "B", and "C") on an annual basis as well as a fairly high frequency of occurrence of stable conditions ("E" and "F") during nocturnal periods. This is due to the high incidence of clear skies and light winds in the district. A more detailed discussion of stability can be found in the regional meteorological discussion. The criteria for determining the stability classes are given in Appendix A of Volume 3.

The visibility in the area is good, averaging between 15 to 16 miles on an annual average. The visibility is best during the summer and lowest during the winter.

Because of the semi-arid nature of this region, relative humidities (and dew points) are quite low throughout the year. The annual average relative humidity at the tract is

56 percent. The annual average dew point is 29°F. The seasonal average relative humidity is lowest during the early summer and highest during the winter, although the actual moisture content of the air is lowest during the winter and highest during the mid to late summer.

Evaporation in the region is greatest during the dry, windy spring months and lowest during the winter months. On an annual average basis, lake evaporation is 50 inches and pan evaporation is 72 inches. The growing season is approximately 140 days, with the first fall freeze occurring in early October and the last spring freeze occurring in mid-May.

The region occasionally experiences heavy, persistent fogs during the winter, when cold air associated with a stationary high pressure system becomes trapped in basins (often over snow-covered ground). The tract experiences about 35 foggy days during a typical year.

Insolation is intense at the tract during most of the year because of the dry air which normally prevails, combined with the relatively high elevation of the site. The tract receives about 512 langleys of insolation during an average day (a total of 186,880 langleys/year). The most insolation is received during June, while the least insolation on a monthly basis is received during December. Cloud cover averages 4.5 out of 10 on an annual average basis. This means that during daylight hours during the year 45 percent of the sky is covered by clouds on the average.

The region seldom experiences severe storms. Duststorms do occur during the spring, but they are normally short-lived because of the steady eastward progression of the storm system involved. Sustained winds of up to 84 miles per hour (extreme mile winds) can be expected once every one hundred years, while

winds of 81 miles per hour can be expected once every 50 years. Blizzards will affect the region on occasion, during the winter or early spring. Severe thunderstorms with strong, gusty winds and/or hail also affect the region occasionally during the late spring and summer. The tract experiences a hailstorm about 6 times during an average year; however, the hailstones are often so small that little damage results.

14.0 DISCUSSION OF CLIMATOLOGY FOR THE PROPOSED RAILROAD THROUGH SAN JUAN COUNTY, WEST OF FARMINGTON (CONSOLIDATED COAL AND EL PASO NATURAL GAS COMPANIES)

The Consolidated Coal Company and the El Paso Natural Gas Company have proposed a 200-foot right-of-way for the construction of a railroad through a portion of San Juan County west of Farmington, New Mexico in the northwestern portion of the Star Lake - Bisti ES region. The tract has several alternate routes under investigation at this time, but will wind through basin topography primarily, and will range in elevation from approximately 5200 to 5800 feet. The climate is best characterized as semi-arid steppe.

Because of the semi-arid nature of this district, diurnal temperature ranges are large. The annual average temperature is about 52°F. The hottest month is July, when temperatures may reach as high as the upper 90's. The coldest month is January, when temperatures as low as -5°F may occur. Small variations in temperature will occur across the tract due to elevation differences.

Precipitation is sparse in the tract, since little surface moisture makes its way into the region from the main moisture source, the Pacific Ocean. The annual average precipitation is 8.4 inches for the southwestern portion of the tract and 9.0 inches for the northeastern portion. There are few orographic influences on precipitation in this tract, so there is little spacial variation in the precipitation totals. The wettest month is August, when an average of 1.5 inches of precipitation occurs, while the driest month is November, when only about 0.4 inch of precipitation occurs.

Snowfall accounts for some of the moisture received in the tract. The average annual snowfall ranges from 22 inches in

the southwestern portion of the tract to 27 inches in the northeastern portion. The greatest monthly snowfall occurs in either December or January, depending on the year inspected.

The surface winds in the tract result from a mixture of synoptic-scale and terrain-induced effects. The prevailing surface wind direction is west-southwesterly. Winds from the northwest and southeast sectors are fairly uncommon, considering the tract as a whole. When both the synoptic-scale pressure gradient is weak and the winds are light, anabatic (upslope) winds may affect a valley location during the day and katabatic (drainage or downslope) winds may occur at night in the valley. The direction of the anabatic or katabatic flow depends on the orientation of the valley.

The strongest winds in the region occur during the spring, when low pressure systems tracking through New Mexico and Colorado cause the development of strong southwesterly and westerly winds. The lightest winds occur during the winter, when pressure gradients are weak and local circulations do not increase the winds appreciably.

The upper air winds, which may occasionally transport pollutants for long distances, are stronger than those winds experienced at the surface because of the absence of frictional effects. These winds normally have a westerly component. A thorough discussion and the data presentation for winds at the 10,000-foot level can be found in the regional meteorological discussion.

A combination of low mixing heights and light transport winds occasionally persists over the region for an extended period of time, causing periods of poor dispersion. These episodes are most frequent during the winter, but also occur during the summer and fall. Poor dispersion conditions are infrequent during the spring because of strong transport winds and frequent air mass changes.

Ground-based radiation inversions are most frequent during the winter and fall and least frequent during the spring. On an annual average basis, the tract experiences low-level inversions approximately 42 percent of the time.

Mixing depths and ventilation are quite variable on a diurnal basis as well as on a seasonal basis at the tract. Morning mixing depths and ventilation values are low throughout the year. During the afternoon, however, the mixing depths and ventilation increase noticeably, particularly during the spring and summer. In general, the lowest mixing depths and ventilation values occur during the winter, when stagnating anticyclones are frequent in the Four Corners region.

The tract receives an unusually high percentage of the unstable Pasquill stability classes ("A", "B", and "C") on an annual basis as well as a fairly high frequency of occurrence of stable conditions ("E" and "F") during nocturnal periods. This is due to the high incidence of clear skies and light winds in the district. A more detailed discussion of stability can be found in the regional meteorological discussion. The criteria for determining the stability classes are given in Appendix A of Volume 3.

The visibility in the area is good, averaging 40 miles on an annual average. The visibility is best during the summer and lowest during the winter.

Because of the semi-arid nature of this region, relative humidities (and dew points) are quite low throughout the year. The annual average relative humidity at the tract is only 48 percent. The annual average dew point is only 30°F. The seasonal average relative humidity is lowest during the early summer and highest during the winter, although the actual moisture content of the air is lowest during the winter and highest during the mid to late summer.

Evaporation in the region is greatest during the dry, windy spring months and lowest during the winter months. On an annual average basis, lake evaporation is 44 inches and pan evaporation is 65 inches. The growing season is approximately 160 days, with the first fall freeze occurring in mid-October and the last spring freeze occurring in early May.

The region occasionally experiences heavy, persistent fogs during the winter, when cold air associated with a stationary high pressure system becomes trapped in basins (often over snow-covered ground). The tract experiences about 15 foggy days during a typical year.

Insolation is intense at the tract during most of the year because of the dry air which normally prevails, combined with the relatively high elevation of the site. The tract receives about 505 langleys of insolation during an average day (a total of 184,325 langleys/year). The most insolation is received during June, while the least insolation on a monthly basis is received during December. Cloud cover averages 4.8 out of 10 on an annual average basis. This means that during the daylight hours during the year 48 percent of the sky is covered by clouds on the average.

The region seldom experiences severe storms. Duststorms do occur during the spring, but they are normally short-lived

because of the steady eastward progression of the storm system involved. Sustained winds of 84 miles per hour (extreme mile winds) can be expected once every one hundred years, while winds of 81 miles per hour can be expected every fifty years. Blizzards will affect the region on occasion, during the winter or early spring. Severe thunderstorms with strong, gusty winds and/or hail also affect the region occasionally during the late spring and summer. The tract experiences a hailstorm about 6 times during an average year; however, the hailstones are usually so small that little damage occurs.

APPENDIX A

CRITERIA FOR DETERMINING PASQUILL STABILITY CLASSES

Source: National Climatic Center, Wind Distribution by Pasquill Stability Classes, Star Program for Selected U.S. Cities, Asheville, N.C. (1970-75).

A STABILITY CLASSIFICATION BASED ON HOURLY AIRPORT OBSERVATIONS

The following explanation of the Pasquill Stability classification has been extracted from an article by D. Bruce Turner in the February 1964 Journal of Applied Meteorology.

This system of classifying stability on an hourly basis for research in air pollution is based upon work accomplished by Dr. F. Pasquill of the British Meteorological Office (1961). Stability near the ground is dependent primarily upon net radiation and wind speed. Without the influence of clouds, insolation (incoming radiation) during the day is dependent upon solar altitude, which is a function of time of day and time of year. When clouds exist their cover and thickness decrease incoming and outgoing radiation. In this system insolation is estimated by solar altitude and modified for existing conditions of total cloud cover and cloud ceiling height. At night estimates of outgoing radiation are made by considering cloud cover. This stability classification system has been made completely objective so that an electronic computer can be used to compute stability classes. The stability classes are as follows: 1) Extremely unstable, 2) Unstable, 3) Slightly unstable, 4) Neutral, 5) Slightly stable, 6) Stable, 7) Extremely stable. Table A-1 gives the stability class as a function of wind speed and net radiation. The net radiation index ranges from 4, highest positive net radiation (directed toward the ground), to -2, highest negative net radiation (directed away from the earth). Instability occurs with high positive net radiation and low wind speed, stability with high negative net radiation and light winds, and neutral conditions with cloudy skies or high wind speeds.

The net radiation index used with wind speed to obtain stability class is determined by the following procedure:

1) If the total cloud cover is 10/10 and the ceiling is less than 7000 feet, use net radiation index equal to 0 (whether day or night).

2) For night-time (night is defined as the period from one hour before sunset to one hour after sunrise):
   a) If total cloud cover $\leq$ 4/10, use net radiation index equal to -2.
   b) If total cloud cover $>$ 4/10, use net radiation index equal to -1.

3) For daytime:
   a) Determine the insolation class number as a function of solar altitude from Table A-2.
   b) If total cloud cover $\leq$ 5/10, use the net radiation index in Table A-1 corresponding to the insolation class number.
   c) If cloud cover $>$ 5/10, modify the insolation class number by following these six steps:
      1) Ceiling $<$ 7000 ft, subtract 2.
      2) Ceiling $\geq$ 7000 ft but $<$ 16,000 ft, subtract 1.
      3) Total cloud cover equal 10/10, subtract 1. (This will only apply to ceilings $\geq$ 7000 ft since cases with 10/10 coverage below 7000 ft are considered in item 1 above.)
      4) If insolation class number has not been modified by steps (1), (2), or (3) above, assume modified class number equal to insolation class number.
      5) If modified insolation class number is less than 1, let it equal 1.
      6) Use the net radiation index in Table A-1 corresponding to the modified insolation class number.

Since urban areas do not become as stable in the lower layers as non-urban areas, stability classes 5, 6 and 7 computed using the STAR program may be combined into a single class (5), or classes 6 and 7 may be combined and identified as class 6.

TABLE A-1. STABILITY CLASS AS A FUNCTION OF NET RADIATION AND WIND SPEED

WIND SPEED (KNOTS)	NET RADIATION INDEX 4	3	2	1	0	-1	-2
0, 1	1	1	2	3	4	6	7
2, 3	1	2	2	3	4	6	7
4, 5	1	2	3	4	4	5	6
6	2	2	3	4	4	5	6
7	2	2	3	4	4	4	5
8, 9	2	3	3	4	4	4	5
10	3	3	4	4	4	4	5
11	3	3	4	4	4	4	4
≥12	3	4	4	4	4	4	4

Stability classes used are based on

Pasquill's class structure (see Journal of Applied Meteorology, February 1964), as follow

Pasquill Stability Class		Definition
1	A	Extremely Unstable.
2	B	Unstable
3	C	Slightly Unstable
4	D	Neutral
5	E	Slightly Stable
6-7	F	Stable to Extremely Stable

TABLE A-2. INSOLATION AS A FUNCTION OF SOLAR ALTITUDE

SOLAR ALTITUDE (a)	INSOLATION	INSOLATION CLASS NUMBER
$60° < a$	Strong	4
$35° < a \leq 60°$	Moderate	3
$15° < a \leq 35°$	Slight	2
$a \leq 15°$	Weak	1